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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER	
SHEVIN, MARK L	
ART UNIT	**PAPER NUMBER**
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/521,424	PEKER, ATAKAN	
	Examiner	Art Unit	
	Mark L. Shevin	4116	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 August 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-28* is/are pending in the application.

4a) Of the above claim(s) *21-28* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-20* is/are rejected.

7)☒ Claim(s) *14* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *14 January 2005* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *22 May 2006*.

4) ☒ Interview Summary (PTO-413) Paper No(s)/Mail Date. *20070928*.

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

<u>*"Method for making dense composites of bulk-solidifying amorphous alloys and articles thereof"*</u>

DETAILED ACTION

Status:

1. Claims 1-28, filed 12 August 2005, are pending. Claims 21-28 are withdrawn from consideration per the telephonic election of invention I, claims 1-20.

Priority

2. The priority date for this application is **17 July 2002**, as the filing date of the provisional application 60/397,981 claimed as part of domestic benefit.

Information Disclosure Statement (IDS)

3. The information disclosure statement (IDS) submitted on 22 May 2006 is in compliance with the provisions of 37 CFR 1.97. Accordingly, it is being considered by the Examiner. Please refer to Applicants' copy of the 1449 submitted herewith.

Restriction

4. Restriction is required under 35 U.S.C. 121 and 372.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1.

In accordance with 37 CFR 1.499, applicant is required, in reply to this action, to elect a single invention to which the claims must be restricted.

Group I, claim(s) 1-20, drawn to a process of making an amorphous-alloy composite.

Group II, claim(s) 21-28, drawn to a product (dense reinforcement-containing bulk solidifying amorphous alloy-matrix composite material).

5. Unity exists only when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding claimed technical features. The express "special technical features" is defined as meaning those technical features that define a contribution which each of the inventions, considered as a whole, makes over the prior art."(Rule 13.2). The question of unity of invention has been reconsidered retroactively by the examiner in view of the search performed; a review of Peker (US 5,567,251) makes clear that the claimed species is not novel over the prior art (the instantly claimed compounds). Furthermore, this reference appears to demonstrate that the technical feature (i.e. metal-matrix composite material having reinforcement materials boned together by an amorphous-metal matrix) does not define a contribution which each of the inventions, considered as a whole, makes over the prior art. Thus, lack of unity becomes apparent "a posteriori" after taking the prior art into consideration. Accordingly, the prior art of the record supports restriction of the claimed subject matter in to the groups as mentioned immediately above.

6. The inventions listed as Groups I and II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

7. The common technical feature, a bulk solidifying amorphous alloy matrix composite, is not a special technical feature as Peker in US 5,567,251 teaches it. Peker teaches a "metal-matrix composite material having reinforcement materials boned together by an amorphous-metal matrix." (Col 2, lines 5-10).

Telephone Election

8. During a telephone conversation with John W. Peck on 17 September 2007 a provisional election was made without traverse to prosecute the invention of the process of making an amorphous-alloy composite, claims 1-20. Affirmation of this election must be made by applicant in replying to this Office action. Claims 21-28 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Specification

9. The disclosure is objected to because of the following informalities:

Page 3, line 4 of the specification has a typographical error, ")T" that is interpreted by the Examiner to ΔT as on page 6, lines 16-19. Appropriate correction is required.

Claim Objections

10. Claim 14 is objected to because of the following informalities: The Examiner interprets claim 14 to read, "...the packing density...is ***at*** least 50%." Appropriate correction is required.

Claim Rejections - 35 USC § 103

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

11. **Claims 1-8, 10-17, 19-20** are rejected under 35 U.S.C. 103(a) as being unpatentable over **Peker** et al (US 5,866,254) in view of **Suresh** (S. Suresh et al. Fundamentals of Metal-Matrix Composites, Chapter 1: Liquid State Processing, Butterworth-Heinemann, Copyright 1993, p. 3-7, 17-18) and **Peker-Johnson** (US 5,288,344 incorporated into 5,866,254 by reference).

Regarding claim 1, Peker '254 teaches the following method of forming a bulk-solidifying amorphous alloy-matrix composite material (See Fig. 4): Feedstock is interpreted as any form of bulk solidifying alloy, including molten metal.

Providing a feedstock of a bulk solidifying amorphous alloy having a critical cooling rate below 500 °C/S (col 2, lines 14-19).

Dispersing a plurality of pieces of a reinforcement material into the bulk amorphous alloy feedstock. (col 2, lines 19-27).

Cooling the particle-reinforced mixture below the glass transition temperature of the bulk solidifying material. (col 7, lines 51-54)

Reheating the solidified composite mixture to a forming temperature (col 7, lines 59-64)

Forming the reheated composite mixture into a desired shape at the forming temperature (col 7, lines 59-64)

Quenching the reheated mixture to an ambient temperature to form an amorphous alloy-matrix composite material. (col 7, lines 56-60).

With regards to the final step of "quenching..." the Examiner interprets the term quenching in light of the specification (page 6, lines 20-23) to simply mean cooling at a rate below 500 °C/S to yield an amorphous bulk metallic glass matrix.

Peker '254 teaches that in dispersing operation of infiltrating the molten bulk metallic glass mixture into a mass of reinforcement, "the matrix material is heated...and

allowed to flow into the mass of reinforcement particles...*or alternatively forced into the mass of reinforcement particles under pressure* (col 7, lines 29-34). Peker '254 does not explicitly teach the ***densification*** of the mixture by applying a force to the molten bulk metallic glass-forming metal.

Suresh teaches the densification of a metal matrix composite by applying a force to the composite at a temperature above the melting point of the metal matrix. In the analogous process of pressure-driven infiltration (very analogous given that Peker '254 mentions "infiltration" in co l8, "Ex 1."), this process is used to overcome poor wetting (p. 5, col 1, para 2, lines 1-5) and generally yields a pore-free matrix (p. 5, col 2, para 1, lines 10-12). Furthermore this process has additional benefits including, "increased processing speed, ... and better soundness of the product through feeding of solidification shrinkage." (p. 5, col 1, para 2, lines 5-9)

It would have been obvious to one of ordinary skill in the arts at the time the invention was made to modify Peker '254 to densify the mixture by applying a force above the melting temperature as such a process is known in the art as taught by Suresh and applying such a process to a metal-matrix composite where the metal matrix is a bulk metallic glass would not be expected to alter the process. One would be motivated to densify the composite above the melting temperature of the matrix as this obviates concerns about wetting behavior as the matrix is forced to flow around the reinforcements and would cause one to have a reasonable expectation of success in yielding stronger composites due to the reduction of porosity.

All other essential elements required by dependent claims 2-8, 10-17, 19-20, are well taught by Peker '254, Suresh, and Peker-Johnson '344 references as follows and thus all the claims are properly included in this rejection.

Regarding claim 2, Peker '254 teaches that above the glass transition temperature, thermal strains are avoided and that the matrix can flow (col 3, lines 5-15).

Regarding claim 3, Peker '254 teaches that the composite can be cooled "without regard to whether the structure of the solid metal is amorphous..." and then can be "...provided to users who remelt and recast the composite material into desired shapes." (col 7, lines 50-64).

Regarding claims 4-7, Peker '254 teaches that the metal matrix bulk solidifying glass should most preferably have a composition, in atomic percent, of $(Zr,Ti)_{45-67}(Cu,Ni)_{10-38}Be_{10-35}$ (Abstract).

Peker-Johnson '344 teaches a number of bulk solidifying glass alloys that fit the general formula of Peker '254 and some of Tg and Tx points for these alloys. One exemplary alloy that has a supercooled liquid regime larger than both 60 C and 90 C is $Zr_{50}Cu_{12.5}Ni_{10}Be_{27.5}$ which has a supercooled regime (as defined in the instant application's specification as Tx-Tg) of 104 C.

'344 teaches that "generally speaking, a higher ΔT indicates a lower critical cooling rate for forming an amorphous alloy. It also indicates that there is a longer time available for processing the amorphous alloy above the glass transition temperature." (col 12, line 65 to col 13, line 4). One would be motivated to select such an alloy with a

ΔT or supercooled liquid regime above 90 C as '344 further teaches that "A ΔT of more than 100 C indicates a particularly desirable glass-forming alloy." (col 13, lines 4-5).

Regarding claim 8, Peker '254 teaches, in regard to his $(Zr,Ti)_{45\text{-}67}(Cu,Ni)_{10\text{-}38}Be_{10\text{-}35}$ class of alloys, that "aluminum can be substituted for the beryllium in an amount up to about half of the beryllium present…" (col 5, lines 60-63).

Regarding claim 10, Peker '254 teaches the reinforcement material should have a melting point at least 600 C above the melting point of the matrix alloy (col 3, lines 7-15).

Regarding claims 11-13, Peker '254 teaches in col 8, Ex. 1, the use of tungsten carbide particles as the reinforcing material. Also see col 4, line 64 to col 5, line 6.

Regarding claim 14, Peker '254 teaches that the infiltration of a melt into a packed mass of particles is a known fabrication technology (col 7, lines 7-11). Furthermore, Suresh teaches that "in infiltration processes, a perform of the reinforcing phase if often formed prior to infiltration…pressing to the desired volume fraction." (p. 17, col 1, section 1.5.1, para 2, lines 1-5). It would obvious to one of ordinary in the art at the time of the invention to increase the packing density of the predensification mixture as a matter of the optimization of process conditions in the course of routine experimentation.

Regarding claim 15, Suresh teaches that creating a vacuum around the reinforcement provides a sufficiently large pressure difference to drive infiltration (p. 5, col 1, para 1, lines 1-3). One can further infer that such a process will reduce porosity (p. 18, col 1, para 2, lines 1-6).

Regarding claim 16, Peker '254 teaches that his bulk solidifying alloy composites can be remelted and recast into various shapes (col 7, lines 51-65) and one of ordinary skill would recognize extrusion above the melting temperature of the matrix as a forming of casting.

Regarding claim 17, Suresh teaches pressure-driven infiltration of a molten metal into a mass of reinforcement material where the pressure in delivered by a piston of a hydraulic press (p. 5, col 1, para 3, lines 1-4), which one of ordinary skill in the art would recognize as producing hydrostatic force.

Regarding claim 19, Suresh teaches that composites produced by pressure-driven infiltration are generally pore-free (p. 5, col 2, lines 10-12) and one of ordinary skill in the art would interpret "pore-free" as meaning greater than 99% dense.

Regarding claim 20, Peker '254 teaches that in the most preferable embodiment of his invention, the reinforcement phase occupies from about 70 to 85 volume percent of the total material (col 4, lines 21-24). One of ordinary skill would further know that too high a volume percent of reinforcement makes a homogenous mixture of reinforcement surrounded by matrix difficult (col 4, lines 16-19).

12. **Claim 18** is rejected under 35 U.S.C. 103(a) as being unpatentable over **Peker** et al (US 5,866,254) in view of **Suresh** (S. Suresh et al. Fundamentals of Metal-Matrix Composites, Chapter 1: Liquid State Processing, Butterworth-Heinemann, Copyright 1993, p. 3-7, 17-18) and **Peker-Johnson** (US 5,288,344 incorporated into 5,866,254 by reference) as applied to claims 1-8, 10-17, 19-20 above and in further view of **Neil** (US 4,952,353)

What Peker '254, Suresh, and Peker-Johnson teach was discussed in the 103 rejection to claim 1 above, and Peker '254 further teaches that the infiltration of a melt into a packed mass of particles is known fabrication technologies for use in other contexts (col 7, lines 8-11) however none of those references teaches the use of hot isostatic pressing.

Neil teaches a hot isostatic pressing as a process for densifying porous articles to produce low porosity articles (col 1, lines 5-10).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to take the combination of Peker '254 (and Peker-Johnson) in view of Suresh and combine it in further view of Neil to use hot isostatic pressing about the melting point of the matrix as Neil taught that hot isostatic pressing in an effective means of porosity removal (col 1, lines 14-16). The instant application also mentions in the specification the use of an encapsulating agent (canning agent) to contain the composite during densification. In Neil's process of hot isostatic pressing, glass is used as the encapsulating agent that melts around the ceramic particles -- one of ordinary skill in the art could utilize this known process with no respective change in its function (changing from glass to a low melting point bulk metallic glass alloy) and yield a reasonable expectation of success in affecting densification.

13. **Claims 8 and 9** are rejected under 35 U.S.C. 103(a) as being unpatentable over **Peker** et al (US 5,866,254) in view of **Suresh** (S. Suresh et al. Fundamentals of Metal-Matrix Composites, Chapter 1: Liquid State Processing, Butterworth-Heinemann, Copyright 1993, p. 3-7, 18.) as applied to claims 1-8, 10-17, 19-20 above, and in further

view of **Szuecs** (F. Szuecs et al, Mechanical properties of $Zr_{56.2}Ti_{13.8}Nb_{5.0}Cu_{6.9}Ni_{5.6}Be_{12.5}$ ductile phase reinforced bulk metallic glass composite, Acta Mater. 49 (2001) p. 1507-1513.)

What Peker '254 and Suresh taught was discussed in the 103 rejection to the independent claim 1 above, however neither reference mentions the inclusion or formation of a ductile crystalline phase precipitate.

Szuecs teaches (p. 1512, col 2, para 2, "conclusions", lines 1-8) "a new class of ductile β phase reinforced bulk metallic glass composites were made by an easily feasible in situ processing method from a homogeneous $Zr_{56.2}Ti_{13.8}Nb_{5.0}Cu_{6.9}Ni_{5.6}Be_{12.5}$ melt. The microstructure of the resulting two phase material consists of a dendritic Zr–Ti rich β phase with a body centered cubic structure, which is embedded in a fully amorphous matrix." The particular bulk solidifying glass alloy used, $Zr_{56.2}Ti_{13.8}Nb_{5.0}Cu_{6.9}Ni_{5.6}Be_{12.5}$, has exceptional glass forming ability with a critical cooling rate below 500 C/S (p. 1507, col 1, lines 1-4). Furthermore, "the preparation of bulk metallic glass matrix composites with ductile metal and refractory ceramic particles as reinforcement has yielded improvements in tensile and compressive strains to failure." (p. 1507, col 1, lines 18-23).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to combine Szuecs with the combination of Peker '254 in view of Suresh established in the 103 rejection to the independent claim 1 above to form a ductile phase as Szuecs teaches that the inclusion of ductile metal precipitates tends to

improve tensile and compressive strains to failure and thus make such a composite stronger.

Additional Relevant Prior Art

14. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

U. Kühn et al, As-cast quasicrystalline phase in a Zr-based multicomponent bulk alloy. Applied Physics Letters, Vol 77, No 22, 13 November 2000, p. 3176-3178.

Kuhn discloses a Zr-Ti-Cu-Ni-Be alloy in the composition range of claims 6 and 7

Bae US 2003/0140987

Bae discloses the inclusion of ductile metallic powders in an amorphous metal matrix (claim 1) which improves the fracture toughness (p. 3, para 0045) as well as plastically forming such a composites at a temperature between Tg and Tx (p. 3, para 0039, lines 1-10)

Ray US 4523621

Ray discloses a method for making amorphous powder and consolidating this powder by hot extrusion. Powders are made by a gas atomization method under the rapid solidification condition. The powder is consolidated by a hot extrusion or a hot forging to obtain a bulk amorphous material without size limitation.

Conclusion

1. Claims 1-20 are rejected.
2. Claim 14 is objected.
3. No claims are allowed

15. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Mark L. Shevin whose telephone number is (571) 270-3588. The examiner can normally be reached on Monday - Thursday, 8:30 AM - 5:00 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vickie Kim can be reached on (571) 272-0579. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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